Numerical Modeling of Acoustic Propagation In a Variable Shallow Water Waveguide

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LONG-TERM GOALS

Random variability in shallow water will induce variability in a propagating acoustic field. The general long-term goal of this research is to quantify how random variability in the ocean environment translates into random variability in the acoustic field and the associated signal processing algorithms. The specific long-term goal for the current funding cycle is to develop a predictive capability for the ambient noise notch in the presence of random ocean internal waves.

OBJECTIVES

The scientific objective of current effort is to understand the effect of internal waves on the ambient noise notch. The ambient noise notch is a trough in the noise directivity pattern that is observed under certain circumstances.

APPROACH

The technical approach to modeling the ambient noise notch is to combine sub models for acoustic propagation, shallow water internal waves, and ambient noise generation. The acoustic propagation sub model is based on the transport theory developed by Dozier and Tappert [1978] augmented to include bottom loss, an important consideration in shallow water. The internal wave sub model is based on a formulation developed by Henyey et al. [1997]. The validity of the model is tested by comparison to data from field experiments. In this testing, we are working with Dajun Tang of APL-UW and using data from the 2001 ASIAEX experiment.

WORK COMPLETED

Sub models for acoustic propagation, shallow water internal waves, and ambient noise generation were combined to develop a model for the ambient noise notch. Initial model testing was completed by comparing noise notch predictions to observations taken in the East China Sea component of ASIAEX.

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14. ABSTRACT
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RESULTS

Figure 1 compares the measured and predicted vertical directivity pattern of ambient noise in the East China Sea. Plotted is the beamformer output versus beamformer look direction relative to horizontal for 2, 3, and 4 kHz. The model accurately predicts both the width and depth of the ambient noise notch that is apparent at all three frequencies. The model uses minimal oceanographic information: the buoyancy profile is estimated from the sound speed profile and the internal wave energy level is estimated from other experiments. The significance of this result is that this implies a new capability to predict the characteristics of the noise notch with minimal environmental input.

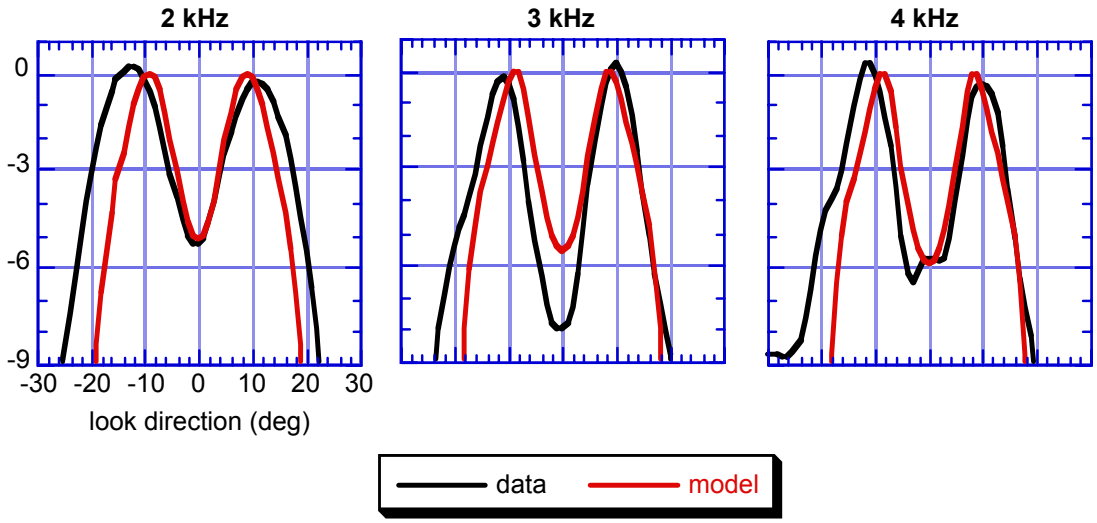

Figure 1: Model/data comparison for East China Sea ambient noise notch.

IMPACT/APPLICATIONS

When present, the ambient noise notch may have significant impact on passive detection schemes; in effect, it creates a window to look through the noise for targets of interest. Being able to predict the extent to which a noise notch will exist at different locations under different oceanographic conditions is highly desirable.

TRANSITIONS

Support to apply the ambient noise notch model to East China Sea data was received from SPAWAR.

RELATED PROJECTS

Additional ambient noise data will be collected in the SW06 experiment. Synoptic measurement of the internal wave field is scheduled as part of the experiment. Ideally, these data could be used to further test and refine our noise notch data.

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